EBMUD HPOAS Nitrogen Removal Optimization Challenges

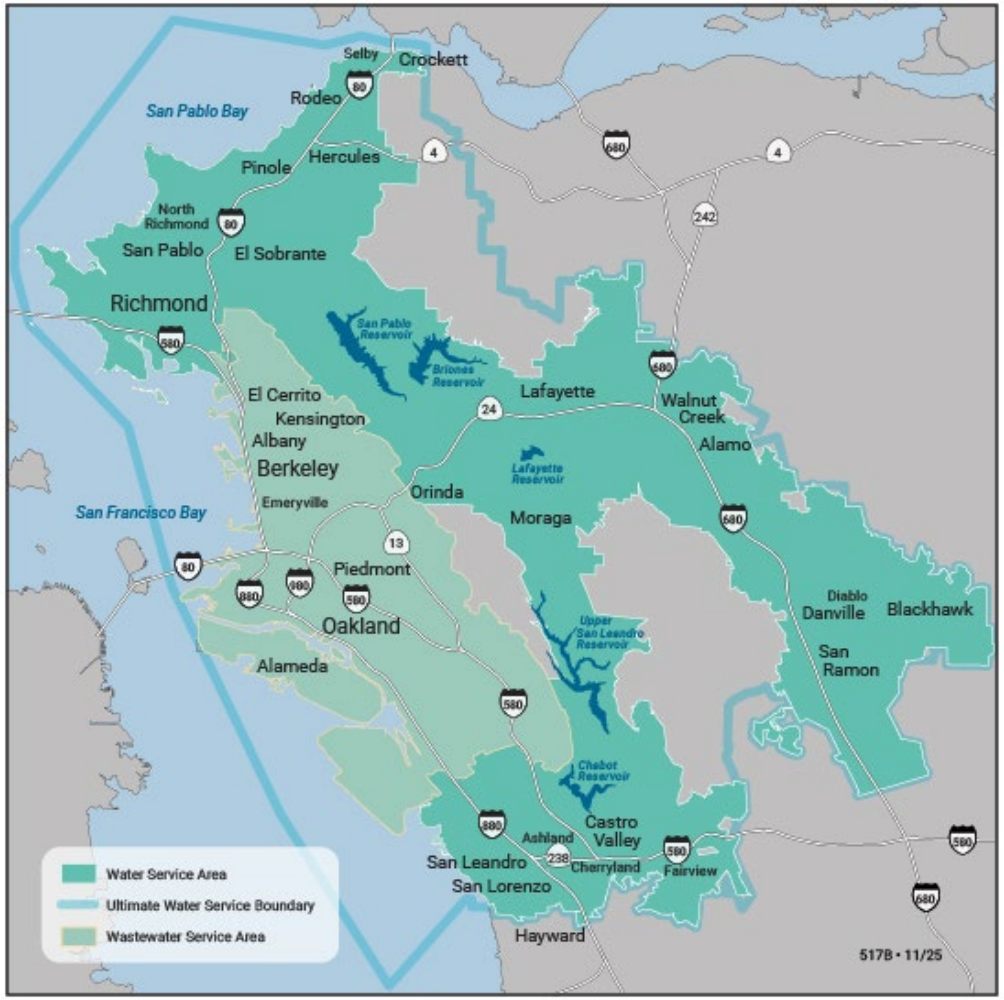
BACWA Nutrient Infoshare 1

June 1, 2026

EBMUD Background

- Water and wastewater services provider
- Wastewater
  - 1 wastewater treatment plant
    - Average dry weather flow: 45 mgd
    - Max flow: 320 mgd (primary), 168 mgd (secondary)
  - 3 wet weather facilities
  - 3 recycled water facilities

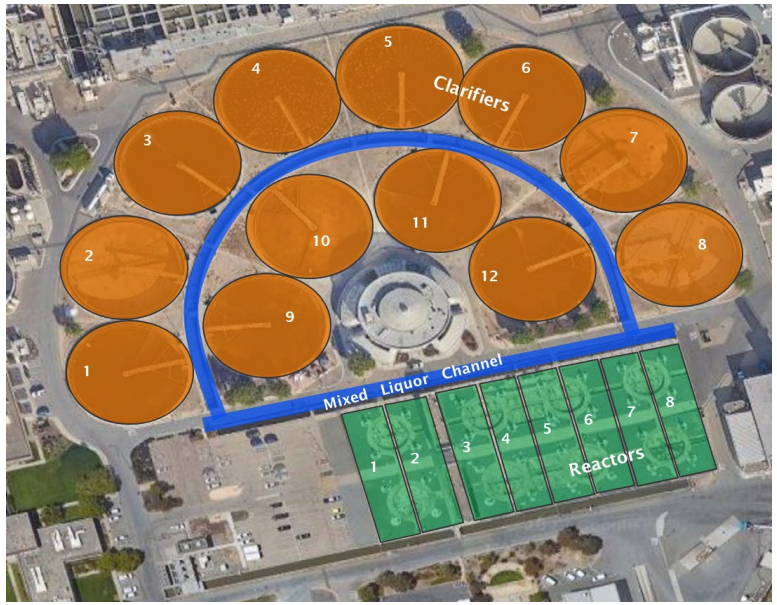
- Nutrients Watershed Permit Limits for EBMUD
  - 11,000 kg N/day starting October 2024
  - 3,300 kg N/d starting October 2034

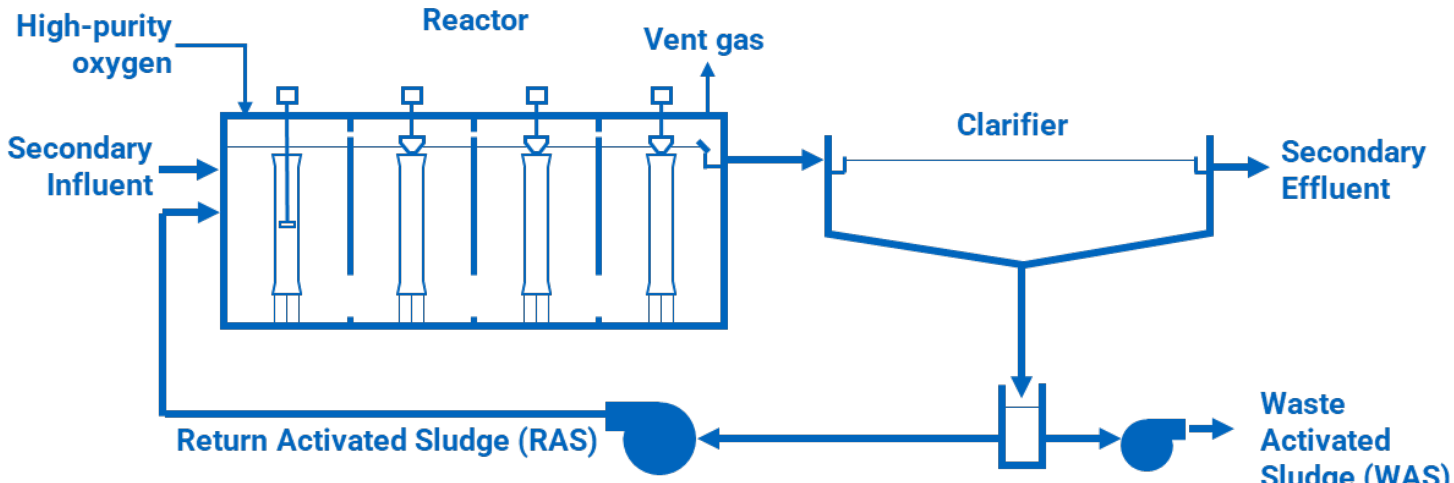


EBMUD Proactive Nitrogen Reduction

2020 – present	Full-scale nitrogen removal pilot
2023	Stopped receiving high nitrogen animal blood wastes
2025	Nutrients Master Plan Update

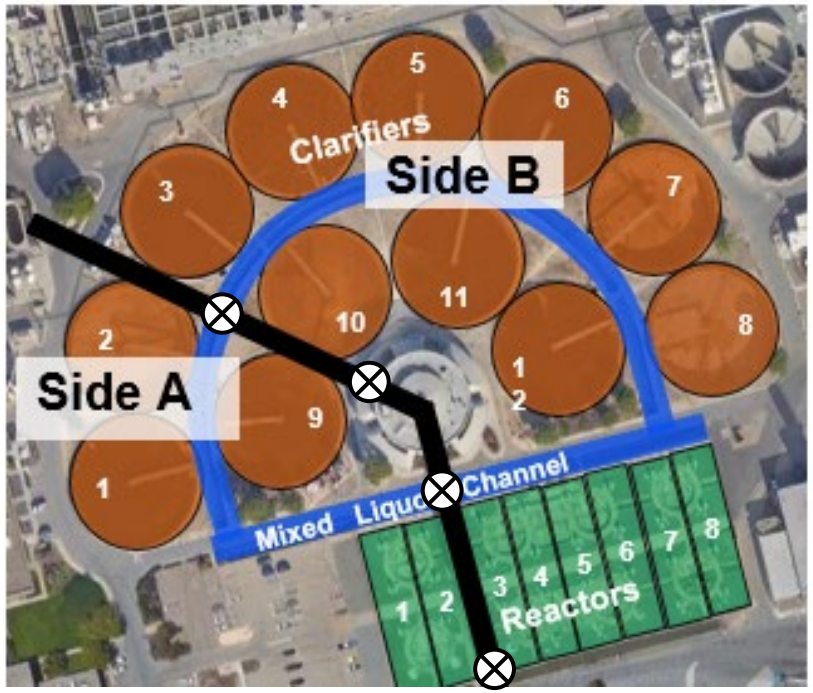
WWTP Secondary System - HPOAS

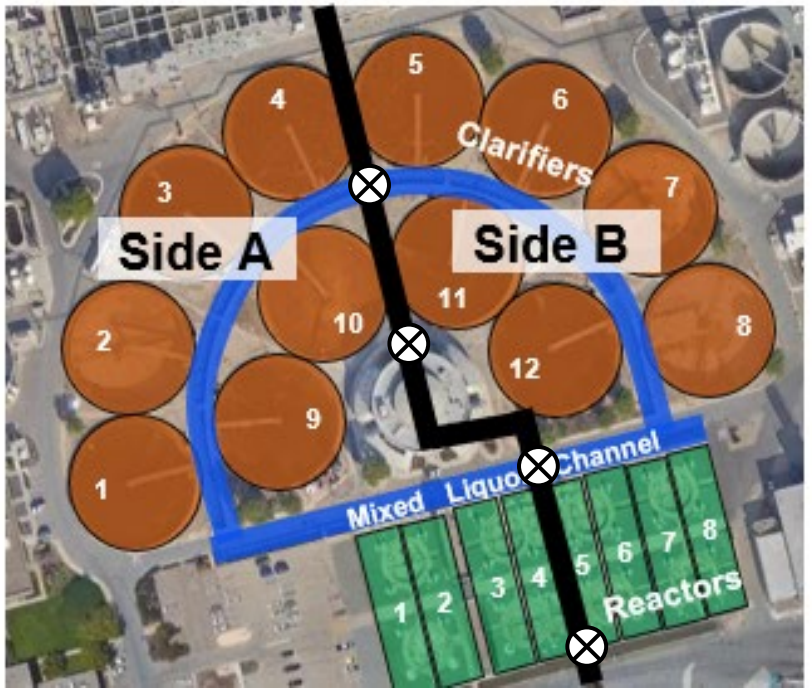




HPOAS = High Purity Oxygen Activated Sludge

Full-Scale Testing by Splitting the WWTP





Secondary system can be split 25/75 or 50/50

EBMUD

BNR Pilot Impact

Table 3-9. Discharge: Dry Season[a] by Discharger, TIN (kg N/d)[b,c]

Discharger	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025[d]	Pre-2025 Average
American Canyon	111	79.7	30.7	20.1	24.7	31.8	29.2	19.4	15.4	11.3	15.0	23.7	28	34.3
Benicia	226	199	198	231	240	236	197	221	227	204	230	240	190	221
Burlingame	436	288	273	273	271	389	450	462	297	256	278	245	270	326
Central San	3,720	3,630	3,380	3,710	3,610	3,550	3,420	3,890	3,900	3,690	3,430	3,410	3,200	3,610
CMSA	844	841	721	964	1,220	954	1,090	1,170	1,100	1,090	997	1,100	1,200	1,010
Port Costa	--	0.0381	--	--	--	--	0.552	2.15	--	--	--	--	1.7	0.913
Delta Diablo	1,630	1,480	869	927	1,350	1,370	1,310	1,320	979	944	1,200	1,320	1,400	1,220
EBDA	7,170	7,190	7,870	7,440	6,940	8,080	7,880	7,700	6,870	6,890	7,320	7,030	7,200	7,370
EBMUD	8,910	9,070	9,390	8,960	9,760	10,200	9,900	8,960	8,410	9,960	7,330	7,610	6,000	9,040

BNR pilot started

Optimization Challenges

- Clarifier solids loading
- Clarifier mechanical damage from N_2 gas
- Long BNR Start Up Period
- BNR Wet Weather Strategy

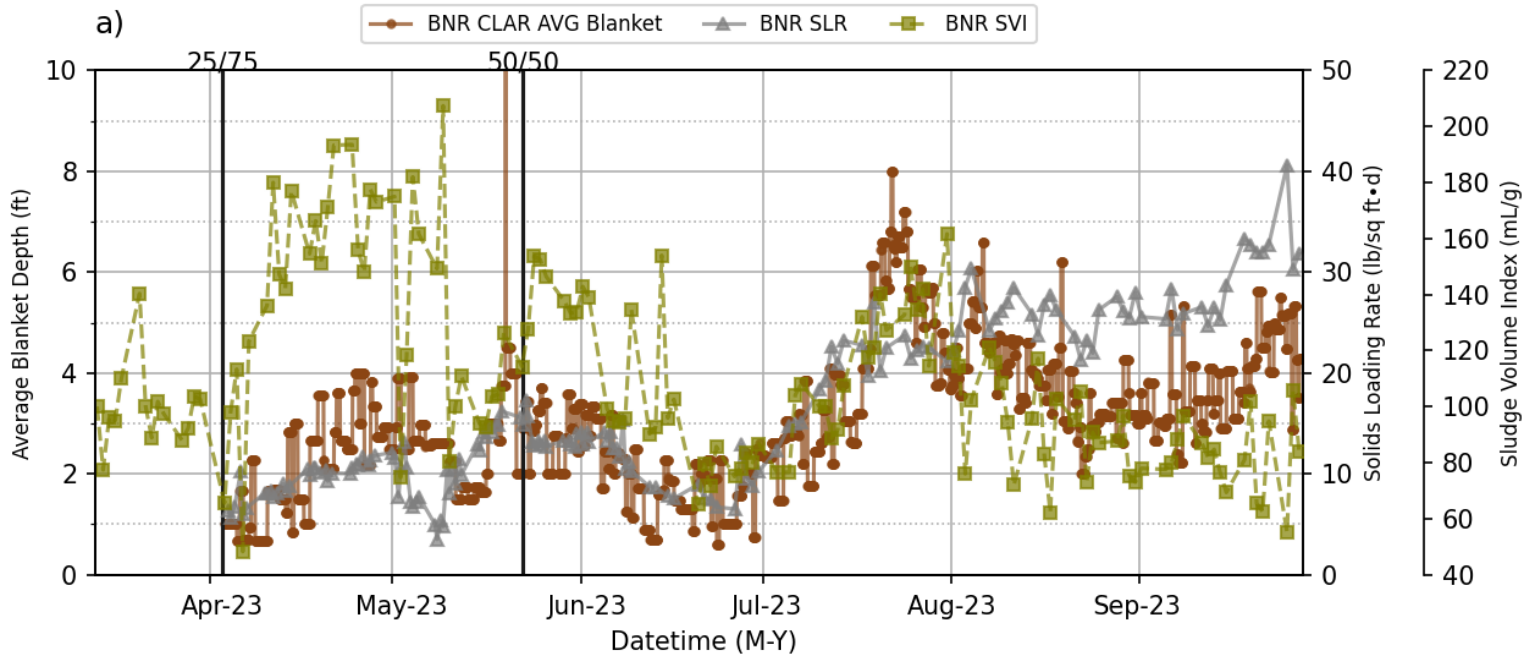
Clarifier Solids Loading

Challenge

- High secondary clarifier blankets

Approach

- Decrease solids loading rate temporarily
  - Increase wasting or reduce flow
- Future investigations to improve SVI



SVI = Sludge Volume Index

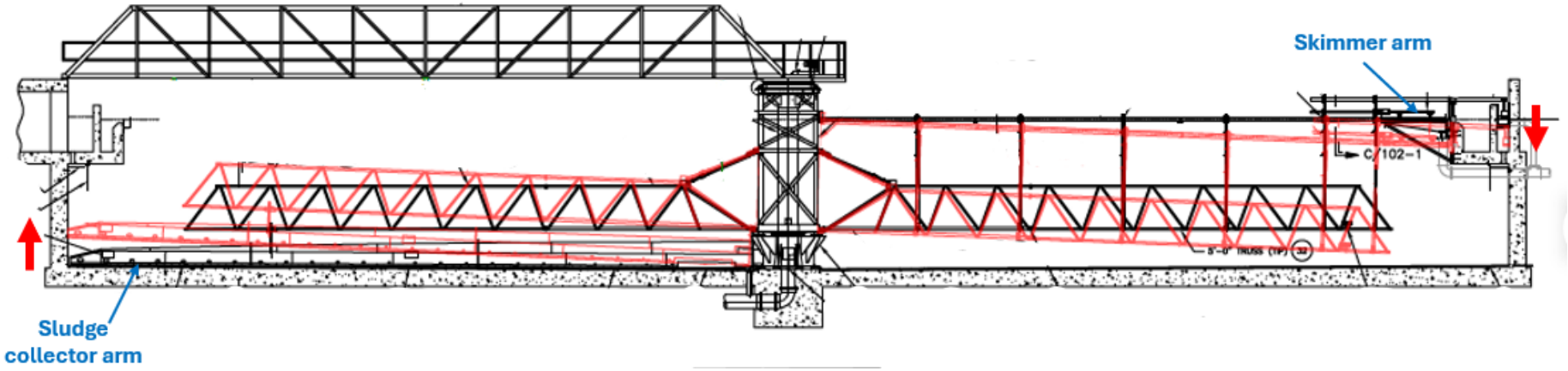
Clarifier Mechanical Damage from N_2 gas

Challenge

- Clarifier skimmer arm elevation drops and gets damaged on clarifier wall

Approach

- Reduce N_2 gas build up in the clarifier sludge
  - Daily release gas from sludge collector arm
  - Use reactor 4th stage for denitrification
  - Increase RAS flow pace >50%



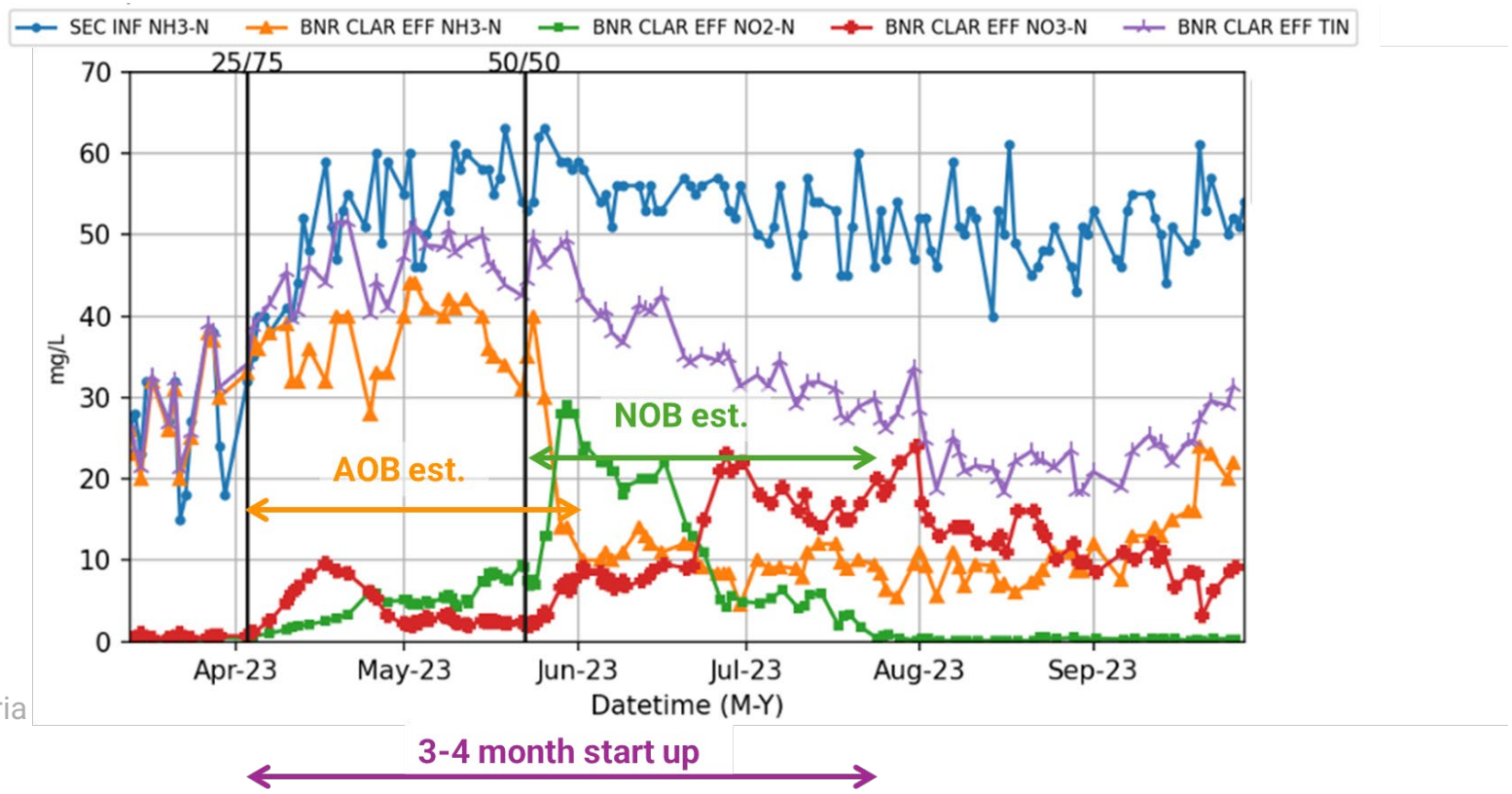
Long BNR Start-up Period

Challenge

- BNR startup can take 3-4 months

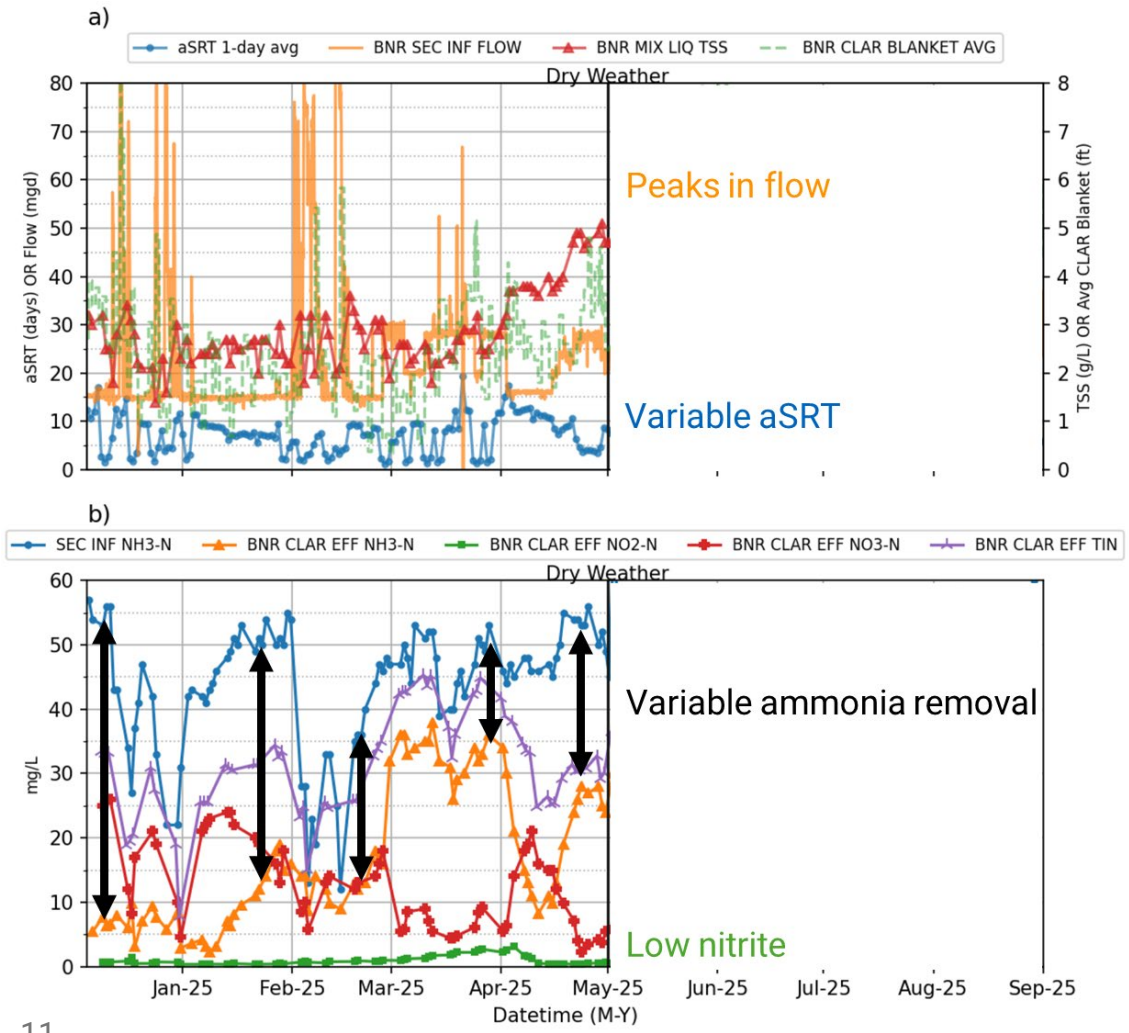
Approach

- Operate BNR through wet weather



AOB = Ammonia oxidizing bacteria
NOB = nitrite oxidizing bacteria

Wet Weather BNR Approach



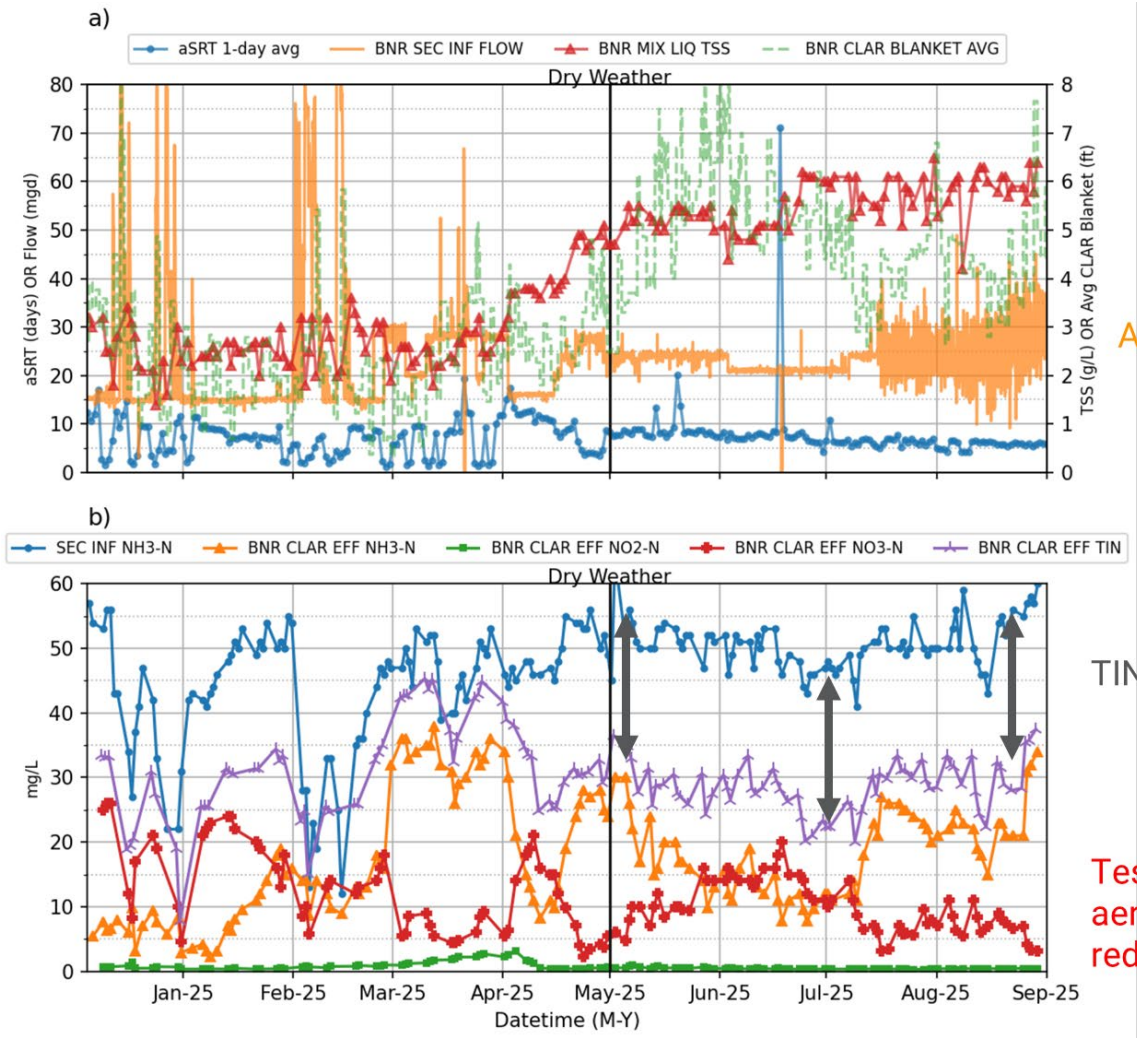
Challenge

- Maintain low secondary clarifier blankets during storm

Approach

- Manage solids inventory based on weather forecast
  - Before rain: waste to settled sludge volume (30 min) below 300 mL/L
  - After rain: allow solids to build up

BNR Startup after Wet Weather Operation



Approx 50% flow

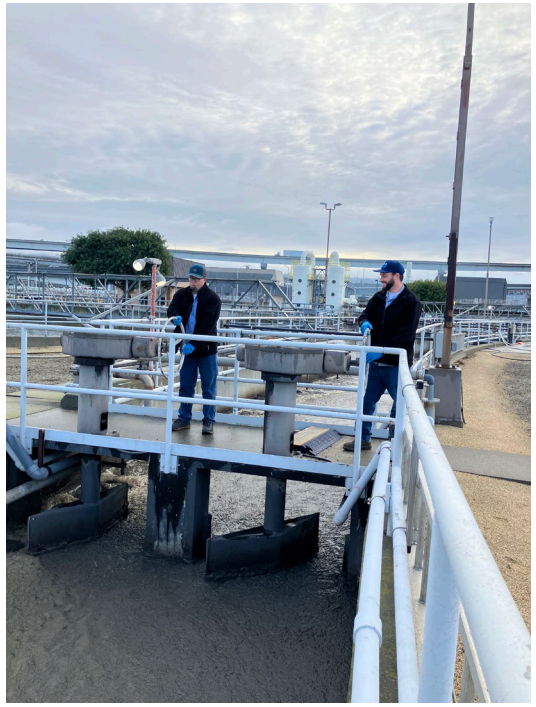
TIN removal ~20 mg/L

Testing 4th stage aeration times to reduce effluent nitrate

Moving Forward

- Conducting Nutrient Master Plan Update
- Continuing BNR Pilot Optimization
- Publishing paper on BNR pilot through the Water Research Foundation

Acknowledgements



This project is a significant collaboration amongst the EBMUD wastewater work groups